BOTTOM TRAWL CODEND MESH SELECTIVITY FOR BAGRUS DOCMAC (FORSKAHL) FROM LAKE VICTORIA, WITH SOME REMARKS ON THE PROPOSED TRAWL FISHERY

by

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ABSTRACT

The methods of estimating codend selectivity fro- alternate hauls are briefly described and applied to Bagrus docmac (Forskahl) data from Lake Victoria. Certain inconsistencies are noted and it is postulated that they may be due to differential escapement of larger B. docmac through the trawl meshes when the different codends were fitted. The calculated 50% selection lengths yielded a fair regression on measured ~~mesh size to give~~ a fork length selection factor of 2.33, consistent with data from the smallest codend mesh size used. The implications of the findings are briefly discussed in relation to the proposed Haplochromis trawl fishery.

The United Nations Development Programme, Food and Agriculture Organization, Lake Victoria Fisheries Research Project, working in conjunction with the East African Freshwater Fisheries Research Organization, has as part of its plan of operations for the management and development of the freshwater fisheries of Lake Victoria, the experimental and exploratory fishing of the lake using the multi-purpose fishing vessel 'IBIS'. The bottom trawling stage of this fishing survey has now been completed. Analysis of the data collected from January 1969 to March 1970 indicates, as was expected, the presence of considerable stocks of Haplochromis spp. which accounted for 80.7% of the estimated ichthyomass (CORDONE, 1970). The estimated total annual commercial catch for 1968 from the traditional Lake Victoria fishery, according to statistics published by the three national fisheries departments, amounted to approximately 111,000 metric tons of which Haplochromis made up only 24.0% (26,630 metric tons). A considerable proportion of the Haplochromis stocks is therefore, unexploited and plans for the future development of the fishery aim at more fully utilising these available stocks.

However, in a multispecies fishery such as exists in Lake Victoria no single species or group of species can be considered in isolation. The increased exploitation of one group may have far reaching effects on other species. CORBET (1961) has already shown that in the north end of the lake Haplochromis is the staple diet of another commercially more valuable fish, Bagrus docmac (Forskahl), the 1968 annual commercial catch of which was 15,565 metric tons or 14.0% of the total. CHILVERS and GEE (unpublished) have demonstrated that CORBET's findings are applicable over the whole lake. One of the direct effects of an increased fishery for Haplochromis may be an immediate reduction therefore, in the available food supply of the more valuable species, B. docmac. COULTER (1970) however, found that commercial exploitation of the pelagic fish community in Lake Tanganyika resulted in increased numbers of the prey species.

Because it is planned to exploit more fully the Haplochromis stocks by bottom trawling, there will be further direct effects on the Bagrus stocks through (a) the increased total fishing effort over their present exploited size range, since Bagrus is always found associated with Haplochromis, although the converse does not necessarily apply; and (b) the new fishing effort of a relatively unselective gear which, due to the considerable disparity in size between Haplochromis spp. and adult Bagrus docmac, will retain small and therefore, young, immature specimens of the latter species which are at present unexploited. The last point is of prime importance since the 'IBIS' data have shown that at certain seasons all sizes of Bagrus present in the population are found on the same fishing grounds. In Lake Victoria, this is a feature peculiar to Bagrus as the other commercially important species are either riverine spawners e.g. Clarias mossambicus Peters, or if lake spawners, then are size segregated e.g. the juvenile stages of Tilapia spp. are found only on shallow inshore nursery grounds whereas the adults are usually offshore (WELCOMME 1964 and 1967).

Even where size segregation does occur, COULTER (1970) has demonstrated that purse seining the pelagic fish community in Lake Tanganyika caused a rapid decline in the numbers of the predators. This decline was brought about over three years by low replacement rates under fishing pressure, although the exploited phase of the predators consisted in the main of large mature specimens.

As an aid to an understanding of some of the effects of a small meshed trawl fishery on the demersal fish community of Lake Victoria, data on codend mesh selectivity for B. docmac are presented here.

THE THEORY OF ESTIMATING SELECTIVITY

The principles underlying the theory of codend selectivity have been established over a number of years for the marine fisheries. BEVERTON and HOLT (1957) and POPE (1966) give adequate summaries of the theory and methodology for such fisheries and the methods described have been adopted in toto during the present work although it has been conducted in freshwater.

The length selection curve for any given mesh size codend may be estimated by comparing the length distribution of fish caught per unit time over its selection range with the length distribution over that range caught by a smaller mesh codend per unit time. The selection range of the smaller mesh codend should be below that of the larger mesh. Theoretically, at those lengths at which there is no escapement through the larger mesh the ratios of the catch at each length from both codends should be unity and the ratios below unity represent the proportion of fish escaping through the larger mesh.

In practice it was found that the ratios always exceeded unity over a greater or lesser length range at the upper end of the initial selection curves, constructed by plotting the catch ratios against their respective lengths. This is a common phenomenon with the alternate haul method of estimating selectivity and BEVERTON and HOLT (1957) suggest that it may be due to an increase in the fishing power of the gear with an increase in codend mesh size.

The initial selection curves however, serve to give only an approximation to the true curves, since if the fishing power of the net is greater with the larger mesh codend for any comparison at the greater fish lengths, then it is reasonable to assume that it is greater over the whole length distribution of the fish caught. Any adjustments made would be applicable therefore, over the whole length distribution. The methods of adjustment are well described by BEVERTON and HOLT (op.cit.) and basically consist of equating the catch ratios at the asymptote of the initial selection curves with unity.

GEAR

The 'IBIS' is 17.1m L.O.A. with a gross metric tonnage of 55. She is powered by a Caterpillar Tractor Marine Type D-333A rated at 180 H.P., fitted with a 3.81:1 reduction gear operating a single screw. This main engine has a forward power take-off with a hydraulic pump to operate the Merco trawl winch.

The trawl used has already been described (ILLUGASON 1969) but has a 71.4 m headrope, 87.0 m groundrope and a length of 67.75 m excluding the codend. It was made at East African Freshwater Fisheries Research Organization/Lake Victoria Fisheries Research Project, Jinja from courlene (Corfiplaste) nos. 3, 5 and 8 with 7.6 cm and 10.2 cm stretched mesh in the lengthening and belly and 12.7 cm mesh in the square and wings. The same small doors and legs were used throughout. The shape and the volumes of the codends were similar to each other. The stretched mesh sizes were believed to be 1.91, 3.81 and 6. 35 cms. At the conclusion of the bottom trawling programme the codend meshes away from the seams were measured in the dry state with vernier calipers at an estimated pressure of 1.68 - 1.71 Kgs. The data are set out in Table 1. The mesh sizes ascertained refer to the inner diagonal lengths of the stretched meshes and are 1.71, 3.11 and 6.21 cm.

Table 1. The internal dimensions of the mesh size measured for each codend at an estimated pressure of 1.68-1.7 Kg

Reference value (cm)	Material	No. of observations	Mean Mesh Size (cm)	Standard Error (cm)	Range (cm)
1.91	Single nylon (210/24)	20	1.71	0.012	1.60-1.92
3.81	Single nylon (210/24)	20	3.11	0.023	2.95-3.33
6.35	Double polypropylene	20	6.21	0.134	5.40-7.66

METHODS

Codend selectivity was estimated using the alternate haul method during normal fishing operations i.e. covered codends were not used. With this method the hauls need not be literally alternate and in the Kagegi Gulf during January 1970 one series of hauls was made with the 6.2 cm mesh codend throughout one day and on the following day the series was repeated using the 3.1 cm mesh codend on the same transects at corresponding times and depths. Also in the Kagegi Gulf the 6.2 cm and 3.1 cm mesh catches for comparison with the 1.7 cm mesh codend catch were carried out on hauls made with the former mesh sizes in similar depths on the same day or one day later than the latter. Elsewhere the hauls were actually alternate.

The hauls were usually of one hour duration at a constant speed of tow of 3 knots. The net therefore, fished the same area of bottom and volume of water with each codend. To achieve this, different proportions of the available horse-power were utilised with each codend. A rough measure of the available horse-power used may be gained from a comparison of the approximate exhaust temperatures noted during fishing operations:

Codend mesh size	(cm)	1.7	3.1	6.2
Exhaust temperature	(^{o}C)	890-900	860-870	840

i.e. there was an inverse relationship between the horse power used and the codend mesh size.

The data are derived from hauls made during various trips of the 'IBIS' to different areas of the lake over the five month period December 1969 to May 1970. In view of their temporal and spatial distribution and the low catches made, they were grouped by trip and not by haul in Section A of Tables 2-4 where the length frequency distributions obtained are shown in part for each pair of codend mesh sizes. Since the codend comparisons were made within and not between trips the catches were corrected where necessary to unit time per trip and the corrected numbers expressed to two decimal places rounded off. The uncorrected numbers i.e. those actually observed, are tabulated as integers. (Table 2)

The catch ratios from each trip are tabulated in Section B of Tables 2-4 and a mean ratio calculated for each length by giving equal weight to the ratios from each set of observations, summing them and dividing by the number of observations per length. The only exception to this was made in Section B, Table 3 where the May 1970 ratio at 11.5 cm based on only 2 fish was ignored in favour of the January 1970 ratio based on 84 fish. (Table 3)

The mean catch ratios aboveunity tended to have a large variance. This may be reduced by smoothing the data, and all mean ratios much above unity in the present work have been smoothed by threes before plotting the initial selection curves (open circles in Fig. 1). (Table 4)

Table 2: Work sheets for calculation of 6.21 cm codend selectivity: Section A shows the number of Bagrus in the 3.11 cm and 6.21 cm codends per trip and Section B the catch ratios adjustment factor and adjusted ratios.

Section A

Area	Mara Bay		Kagegi Gulf		Ukerewe I. to Tanzania/Kenya border		Kavirondo Gulf Kenya	
Date	Dec 1969		Jan 1970		March 1970		May 1970	
Trawling Time	1 hr		9 hrs		1 hr		3 hrs	
Mesh (cm)	3.11	6.21	3.11	6.21	3.11	6.21	3.11	6.21
Fork length (cm)								
4.5	-	-	-	-	-	-	3.00	-
5.5	-	-	-	-	-	-	6.00	-
6.5	-	-	-	-	-	-	11.25	1
7.5	-	-	-	-	-	-	23.25	-
8.5	-	-	-	-	-	-	10.50	-
9.5	-	-	29	-	-	-	6.75	1
10.5	-	-	39	-	-	-	0.75	-
11.5	-	-	141	12.0	2	-	2.25	1
12.5	3	1	178	27.5	7	-	0.75	-
13.5	7	2	115	59.0	7	5	4.50	2
14.5	6	1	57	59.3	11	6	3.75	1
15.5	1	2	50	29.2	8	7	3.00	4
16.5	-	3	33	12.2	2	6	4.50	6
17.5	2	5	31	2.0	1	2	6.00	7
18.5	-	3	35	16.0	-	1	3.75	9
19.5	2	5	23	22.0	-	1	6.00	10
20.5	5	6	22	16.7	1	3	13.50	14
21.5	3	4	12	10.5	2	2	14.25	20
22.5	4	7	10	10.0	3	1	15.00	18
23.5	1	5	12	12.0	2	3	12.75	17
24.5	3	5	9	4.0	-	2	15.75	11
25.5	1	2	10	3.2	2	2	9.75	9
SUM	38	51	806	295.6	48	41	187.00	131

Section B

Ratio of catches of large to small meshed codends						
Dec. 1969	Jan. 1970	March 1970	May 1970	Mean	Mean smoothed by threes	Adjusted ratios
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	0.09	0.09	-	0.06
-	-	-			-	-
-	-	-			-	-
-	-	-	0.15	0.15	-	0.10
-	-	-			-	
-	0.09	-	0.44	0.27	-	0.19
0.33	0.15	-		0.24	-	0.17
0.29	0.51	0.71	0.44	0.49	-	0.34
0.17	1.04	0.55	0.27	0.51	-	0.35
2.00	0.58	0.88	1.33	1.20	1.09	0.76
-	0.37	3.00	1.33	1.57	1.40	0.97
2.50	0.06	2.00	1.17	1.43	1.48	1.03
-	0.46	-	2.40	1.43	1.52	1.06
2.50	0.96	-	1.67	1.71	1.55	1.08
1.20	0.76	3.00	1.04	1.50	1.45	1.01
1.33	0.88	1.00	1.40	1.15	1.24	0.86
1.75	1.00	0.33	1.20	1.07	1.48	1.03
5.00	1.00	1.50	1.33	2.21	1.41	0.98
1.67	0.44	-	0.70	0.94	1.40	0.97
2.00	0.32	1.00	0.92	1.06		
				Mean = 1.44		

Table 3 : Work sheets for calculation of 6.21 cm codend selectivity; Section A shows the number of fish in the 1.71 cm and 6.21 cm codends per trip and Section B the catch ratios with the adjustment factor and the adjusted ratios.

Section A

Area	Kagegi Gulf		Ukerewe I. to Tanzania/Kenya border		Kavirondo Gulf Kenya	
Date	Jan. 1970		March 1970		May 1970	
Trawling Time	1 hr		1 hr		3 hrs	
Mesh (cm)	1.71	6.21	1.71	6.21	1.71	6.21
Fork length (cm)						
4.5	–	–	–	–	10	–
5.5	–	–	–	–	26	–
6.5		–	–	–	49	1
7.5	–	–	–	–	43	–
8.5	–	–	–	–	19	–
9.5	–	–	–	–	8	1
10.5	42	–	–	–	2	–
11.5	72	12.00	1	–	1	1
12.5	108	27.50	3	–	1	–
13.5	97	55.00	9	5	4	2
14.5	33	53.30	5	6	4	1
15.5	17	17.20	3	7	5	4
16.5	6	1.70	3	6	10	6
17.5	–	–	3	2	8	7
18.5	–	–	1	1	9	9
19.5	–	–	1	1	20	10
20.5	–	1.20	–	3	14	14
21.5	3	–	–	2	22	20
22.5	2	–	3	1	24	18
23.5	1	–	4	3	18	17
24.5	4	–	4	2	11	11
25.5	1	1.20	6	2	6	9
SUM	386	169.10	46	41	314	131

Section B

Ratio of catches of large to small meshed codend						
Jan. 1970	March 1970	May 1970	Mean	Means smoothed by threes	Adjustment factor (Y)	Adjusted ratios
–	–	–	–	–	–	–
–	–	–	–	–	–	–
–	–	0.02	0.02	–	1.26	0.02
–	–	–	–	–	–	–
–	–	–	–	–	–	–
–	–	0.13	0.13	–	1.18	0.11
–	–	–	–	–	–	–
0.17	–	(1.00)	0.17	–	1.13	0.15
0.25	–	–	0.25	–	1.10	0.23
0.57	0.56	0.50	0.54	–	1.08	0.50
1.62	1.20	0.25	1.02	0.98	1.05	0.93
1.01	2.33	0.80	1.38	1.12	1.02	1.10
0.28	2.00	0.60	0.96	1.04	0.99	1.05
–	0.66	0.88	0.77	0.91	0.97	0.94
–	1.00	1.00	1.00	0.84	0.94	0.89
–	1.00	0.50	0.75	0.92	0.91	1.01
–	–	1.00	1.00	0.89	0.89	1.00
–	–	0.91	0.91	0.81	0.86	0.94
–	0.33	0.75	0.54	0.77	0.83	0.93
–	0.75	0.94	0.85	0.71	0.81	0.88
–	0.50	1.00	0.75	0.85	0.78	1.09
1.00	0.33	1.50	0.94	0.84	0.75	1.12
				$Y = 1.44 - 0.027X$		

Table 4: Work sheets for the calculation of 3.11 cm codend selectivity: Section A shows the number of fish in the 1.71 cm and 3.11 cm codends per trip and Section B the catch ratios with the adjustment factor and the adjusted ratios.

Section A

Area	Kagegi Gulf Uganda		Ukerewe I. to Tanzania/Kenya border		Kavirondo Gulf, Kenya	
Date	Jan 1970		March 1970		May 1970	
Trawling Time	1 hr		1 hr		3 hrs	
Mesh (cm)	1.71	3.11	1.71	3.11	1.71	3.00
Fork length (cm)						
4.5	-	-	-	-	10	3.00
5.5	-	-	-	-	26	6.00
6.5	-	-	-	-	49	11.25
7.5	-	-	-	-	43	23.25
8.5	-	-	-	-	19	10.50
9.5	-	-	-	-	8	6.75
10.5	42	-	-	-	2	0.75
11.5	72	26	1	2	1	2.25
12.5	108	33	3	7	1	0.75
13.5	97	47	9	7	4	4.50
14.5	33	51	5	11	4	3.75
15.5	17	26	3	8	5	3.00
16.5	6	-	3	2	10	4.50
17.5	-	-	3	1	8	6.00
18.5	-	-	1	-	9	3.75
19.5	-	1	1	-	20	6.00
20.5	-	1	-	1	14	13.50
21.5	3	1	-	2	22	14.25
22.5	2	4	3	3	24	15.00
23.5	1	1	4	2	18	12.75
24.5	4	2	4	-	11	15.75
25.5	1	1	6	2	6	9.75
SUM	386	194	46	48	314	187.00

Section B

Ratio of catches of large to small meshed codends						
Jan. 1970	March 1970	May 1970	Mean Ratio	Means smoothed by threes	Adjustment factor	Adjusted ratios
-	-	0.30	0.30	-		0.26
-	-	0.23	0.23	-		0.20
-	-	0.23	0.23	-		0.20
-	-	0.54	0.54	-		0.47
-	-	0.55	0.55	-		0.47
-	-	0.84	0.84	-		0.72
-	-	0.38	0.38	0.91		0.78
0.36	2.00	2.25	1.54	1.02		0.88
0.31	2.33	0.75	1.13	1.16		1.00
0.48	0.78	1.13	0.80	1.16		1.00
1.55	2.20	0.94	1.56	1.32*	1.16	1.14
1.53	2.67	0.60	1.60	1.24		1.07
-	0.67	0.45	0.56	0.90		
-	0.33	0.75	0.54	0.51		
-	-	0.42	0.42	0.42		
-	-	0:30	0.30	0.56		
-	-	0.96	0.96	0.58		
0.33	-	0.65	0.49	0.89		
2.00	1.00	0.63	1.21	0.81		
1.00	0.50	0.71	0.74	0.97		
0.50	-	1.43	0.97	0.90		
1.00	0.33	1.63	0.99			

APPLICATION OF THE THEORY TO THE *BAGRUS* DATA

The existing data for the 6.2 cm and 3.1 cm comparisons with the 1.7 cm mesh codend (Tables 3 and 4) show that at lengths greater than 15.5 cm the numbers of fish retained by the former codends are less than those retained by the latter. Their catch ratios therefore, after exceeding unity decrease below this value. This trend is particularly marked for the 3.1/1.7 cm codend comparison (see Table 4) and could be due to further escapement of *Bagrus* elsewhere in the trawl when the larger codends are fitted. Escapement from areas of the trawl other than the codend has been demonstrated for various species of marine fish by CLARK, ELLIS or MARGETTS (1963), DICKSON (1964) and ZIJLSTRA (1967). In a series of comparative fishing trials to study the effects of reducing the mesh size of forward parts of the trawl, DICKSON (op.cit.) found that this resulted in increased catches of the larger specimens of demersal species. It might be surmised therefore, that fitting the 1.7 cm mesh codend resulted in deformation of meshes in the trawl, reducing their lumen, thereby producing a similar effect to that noted by DICKSON (1964). In support of this assumption it should be noted that catches were much larger when the smaller volume 1.7 cm mesh codend was fitted; so much so, that part of the catch was usually trapped in the after end of the trawl net itself, almost certainly imposing much greater drag on the forward parts of the net. Therefore, assuming that differential selection with respect to size occurred between hauls made with the various codends once the 1.7 cm mesh codend had filled, only data from those lengths in the 3.2/1.7 cm codend comparison at which the smoothed mean catch ratios were above or only slightly less than unity were used to construct the initial and adjusted selection curves.

(Fig. 1)

It may be seen from Figs. 1A and 1C that the initial curves for the 6.2/3.1 cm and the 3.2/1.7 cm comparisons tend to an upper asymptote with the plotted values fluctuating around an average of 1.44 and 1.16 respectively (Section B, Tables 2 & 4). Using these averages as the adjustment factors in each case, the mean and the smoothed catch ratios were divided by the averages to obtain the adjusted ratios shown in the last columns of Tables 2& 4. These adjusted ratios are shown plotted as solid circles in Figs. 1A and 1C joined by a free hand smooth curve to yield estimates of the 6.2 and 3.1 cm mesh codend 50% selection lengths (see Table 5).

The initial selection curve for the 6.2/1.7 cm comparison shown in Fig. 1B presents a further variation in that the ratios after exceeeding unity demonstrate an approximately linearly decreasing trend. BEVERTON and HOLT (op.cit.) described a similar situation with respect to plaice and showed that a suitable adjustment can be made by calculating the linear regression equation describing this trend and then calculating Y, the adjustment factor, in the generalised equation $Y = a + bX$, for each value of X. In the generalised equation, a is the intercept on the ordinate corresponding to fish length of zero, b is the regression coefficient and X is fish length. The equation for the 6.2/1.7 cm *Bagrus* data fitted by the method of least squares was

$$Y = 1.44 - 0.027X$$

and the value of Y are tabulated in the penultimate column of Table 3. The last column of Table 3 shows the adjusted ratios plotted in Fig. 1B as solid circles joined by a freehand smooth curve to yield another estimate of the 50% selection length for the 6.2 cm mesh codend, which is however lower than the previous estimate.

Table 5. The estimated 50% codend selection lengths and the selection ranges from 25% to 75% for each of the three trials for *Bagrus docmac* and their conversions into standard length measurements

Mesh size (cm)	L_F Fork length (cm)				L_{S2} Taxonomic standard length (cm)				L_{S1} Fisheries standard length (cm)			
	50%	25%	75%	Range	50%	25%	75%	Range	50%	25%	75%	Range
6.21	14.5	12.9	15.5	2.6	13.2	11.7	14.1	2.4	12.9	11.5	13.8	2.3
6.21	13.6	12.6	14.1	1.5	12.3	11.4	12.8	1.4	12.1	11.2	12.6	1.4
3.11	8.0	5.7	10.2	4.5	7.2	5.0	9.2	4.2	7.1	5.0	9.1	4.1

The two estimates differ by 0.9 cm as Table 5 shows but in view of the greater amount of data available from the 6.2/3.1 cm comparisons (14 hours trawling) compared with the 6.2/1.7 comparisons (5 hours trawling), the former estimate of 14.5 cm is probably more reliable than the latter of 13.6 cm. (Table 5).

Theoretically, the regression of the 50% retention lengths on mesh size should pass through the origin and the regression coefficient would then give an estimate of the selection factor for the species concerned. Obviously, the measure of the regression coefficient will differ for different conventions of fish measurement - fork length, standard length etc. Accordingly, the 50% retention lengths and the selection range from 25% to 75% retention have been tabulated (Table 5) for fork length, the length actually measured, and additionally for the two standard lengths, taxonomic (L_{S2}) and fisheries standard length (L_{S1}) the usual linear measurement for Bagrus on the 'IBIS' (see CHILVERS 1970). These latter values were calculated from the fork length estimates, using the conversion factors computed by CHILVERS (op.cit.).

The 50% fork retention lengths are shown plotted against mesh size in Fig. 2 with a line drawn through the origin from the most reliable estimate for the 6.2 cm mesh codend. It may be seen that the other estimate for this size of codend and the 50% estimated for the 3.1 cm mesh fall on either side of this regression line which may therefore, be regarded as a reasonable fit to the plotted data.

Fig. 2

The somewhat higher rention length for the 3.1 cm mesh is due in part to the fact that the selection ranges of the 1.7 cm and the 3.1 cm meshes overlap (see Section A, Table 4), confounding the estimated selection curve for the 3.1 cm mesh. This may be deduced from the much greater estimated selection range for the 3.1 cm mesh shown in Table 5. Further analysis of the 3.1 cm mesh codend selection curve according to BEVERTON and HOLT (op.cit.) was not carried out since it was considered that the data were inadequate and it was suspected that the smallest Bagrus which would be retained by the 1.7 cm mesh codend were not available in the population over the whole period for which these comparisons were made. The fact that the 3.1 cm mesh codend was made up from single nylon whereas the 6.2 cm codend was double polypropylene would also contribute to its higher 50% retention length. POPE (1966) under the heading "Codend Material" cites many examples of this.

Since the regression line (Fig. 2) through both the origin and the first calculated 50% retention estimate for the 6.2 cm mesh fits the remaining fork length estimates fairly well, the selection factor may be calculated by dividing this 50% retention length by the codend mesh size. Similar calculations will yield the selection factors for the standard length conversions. The calculated selection factors were:

Fork length	Taxonomic standard length	Fishery standard length
L_F	L_{S2}	L_{S1}
2.33	2.13	2.08

A small additional check on the validity of the fork length selection factor may be gained from calculating the 50% selection length for the 1.7 cm mesh, $2.33 \times 1.71 \simeq 4.0$ cms. Data from the May 1970, Kavirondo Gulf catches (Tables 3 and 4) are consistent with this result.

Since there are no other data relating to Bagrus available from elsewhere for comparison purposes, the factors call for no comment beyond noting that they are at the lower end of the range (2.0 - 5.0) mentioned by POPE (1966) for selection factors obtained from experiments in North Atlantic waters.

PRACTICAL APPLICATIONS

The importance of the selection factor is based upon the fact that from it the 50% retention length for any mesh size can be calculated. If knife edge selection is assumed, and from the ranges shown in Table 5 this assumption would not introduce any great error, then one can generalise and state that all fish above the retention length entering the trawl will be caught and all fish below, will escape. This has an important bearing on any trawl fishery for Bagrus alone since it is apparent from the length frequencies shown in Tables 2 & 4 that at certain seasons on specific grounds, all sizes, and therefore all ages of Bagrus will be present in the exploited stocks. The use of codends with a stretched mesh size of less than 7.62 cm will destroy considerable quantities of yearling fish since it has been demonstrated (CHILVERS 1969) that 1 year old Bagrus attain a mean mid standard length (L_{S1}) of 14.3 cm whereas the 50% retention length of such a codend mesh size would be 15.8 cm. However, these small fish are found in large numbers in deep water, usually associated with rocky areas e.g. south of the Sesse Isles in Kagegi Gulf, where trawling over the whole ground is impracticable. Such areas would therefore, serve as refuges or safe areas in which part of the small Bagrus stocks could develop undisturbed by trawling operations.

The traditional gillnet fishery for Bagrus is based mainly upon 11.4 cm and 12.7 cm stretched mesh gillnets. Data collected by BERGSTRAND (personal communication) from fishing camps on Ingira Island from August 1969 to January 1970 demonstrate that the mean standard lengths (L_{S1}) for Bagrus caught by these nets are 32.9 and 37.9 cm respectively, i.e. age 3 and 3½ years. Trawl nets with codends of these sizes, assuming knife edge selection, would retain Bagrus of standard lengths greater than 23.8 and 26.4 cm respectively i.e. approximately 2 years old. With the use of gillnets of these sizes there are indications that the Bagrus fishery has declined from 1964 as the data from the Annual Report of the Tanzania Fisheries of Lake Victoria 1968 shown in Table 6 indicate (see also CHILVERS and MANN, 1970).

Table 6: Total annual landings of Bagrus docmac in Tanzania

Year	Metric tons	Year	Metric tons
1958	5,616	1964	15,064
1959	12,618	1965	14,301
1960	5,240	1966	10,541
1961	5,334	1967	9,251
1962	9,365	1968	9,442
1963	10,650		

The effect of a trawl fishery using codend mesh sizes similar to those used in the gillnet fishery can only intensify this decline in view of the much greater length range of Bagrus caught by the former gear. Such codend mesh sizes would not however, retain Haplochromis (GEE, 1969) and there is therefore, a very real danger that uncontrolled trawling for Haplochromis with, of necessity, small mesh codends will, in time, progressively reduce the economically important Bagrus fishery by increasing the mortality of the existing breeding stocks in addition to destroying the potential spawners. The progressive reduction in the value of the adult Bagrus catches in the trawl, gillnet and longline fisheries must be off-set against the increased value of the Haplochromis trawl catches.

"Two convincing examples from world fisheries of the decline of large predatory species through the use of small meshed gear have recently been described; COULTER (1970) has documented the effects of a purse seine fishery for Stolothrissa and Limnothrissa in Lake Tanganyika with subsequent reduction to a low level of the numbers of the predators Lates and Luciolates; REGIER et al. (1969) found that a population of walleye (Stizostedion vitreum) was maintained at a low level by a small meshed gillnet fishery for yellow perch (Perca flavescens) and white bass (Morone chrysops) in Lake Erie".

Control of the proposed trawl fishery should therefore be imposed at the outset possibly by limiting the number of trawlers operating and/or by excluding trawlers from those areas already known to harbour small specimens of Bagrus.

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SUMMARY

Recent exploratory bottom trawling in Lake Victoria has demonstrated the presence of large unexploited stocks of Haplochromis spp. which it is proposed to trawl commercially. Bagrus docmac (Forkskahl), a large predatory species, preys almost exclusively on Haplochromis with which it is therefore, always associated. All sizes of B. docmac are found together and a small meshed trawl fishery may thus, rapidly deplete its stocks. Bottom trawl codend selectivity for B. docmac has therefore, been estimated, using the alternate haul method, as an aid to understanding some of the effects of a small meshed trawl fishery on the demersal fish community. The methods are briefly described and certain inconsistencies noted when applied to the data. It is postulated that these could be due to differential escapement of larger B. docmac through the trawl meshes with the different codends. The calculated 50% selection lengths yielded on fair regression on measured mesh size to give a fork length selection factor of 2.33, consistent with data from the smallest codend mesh size used. Utilising this factor, 50%

selection lengths for various mesh sizes were shown to be considerably lower than the mean lengths retained by the existing large meshed gillnet fishery, the B. docmac landings from which are already declining in Tanzania. It is predicted that this delcine will intesify unless the proposed *Haplochromis* trawl fishery is controlled from the outset.

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Fig 1 : *Bagrus docmac* codend mesh selection curves a) for the 6.21 cm mesh from 6.21/3.11 cm ratios b) for the 6.21 cm mesh from 6.21/1.71 cm ratios and c) for the 3.11 cm mesh from 3.11/1.71 cm ratios.

O initial unadjusted ratios ʘ final adjusted ratios with the selection ogives represented by the thick line.

Fig 2 : The regression of 50% selection lengths for *Bagrus docmac* on codend mesh size.